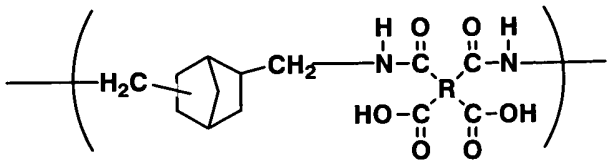
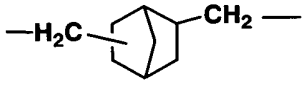
CLAIM

1. A polyamic acid having repeating units represented by the formula (1):

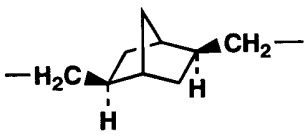


(1)

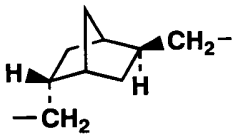
wherein the norbornane skeleton of



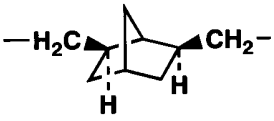
comprises four components of



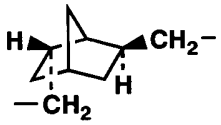
2,5-[diexo]



2,5-[exo,endo]



2,6-[diexo]



2,6-[exo,endo]

and their contents satisfy the following:

$$1\ \% \leq 2,5\text{-[diexo]} \leq 90\ \%,$$

$$1\ \% \leq 2,5\text{-[exo,endo]} \leq 90\ \%,$$

$$1\ \% \leq 2,6\text{-[diexo]} \leq 90\ \%,$$

$$1\ \% \leq 2,6\text{-[exo,endo]} \leq 90\ \%,$$

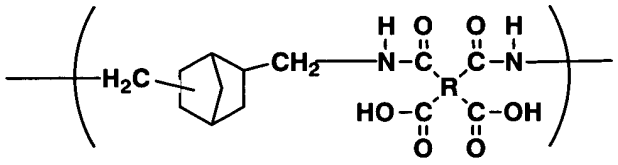
provided that

$$(2,5\text{-[diexo]}) + (2,5\text{-[exo,endo]}) + (2,6\text{-[diexo]}) + (2,6\text{-[exo,endo]}) = 100\ \%,$$

R represents a tetravalent group having from 4 to 27 carbon atoms and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic

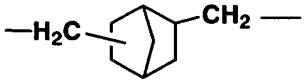
aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

2. A polyamic acid having repeating units represented by the formula (1):

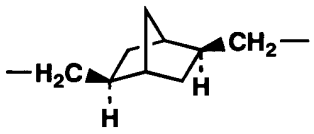


(1)

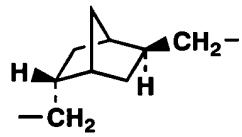
wherein the norbornane skeleton of



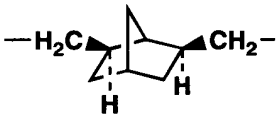
comprises four components of



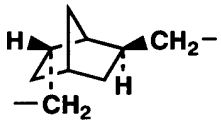
2,5-[diexo]



2,5-[exo,endo]



2,6-[diexo]



2,6-[exo,endo]

and their contents satisfy the following:

$$10\ \% \leq \text{2,5-[diexo]} \leq 40\ \%,$$

$$10\ \% \leq \text{2,5-[exo,endo]} \leq 40\ \%,$$

$$10\ \% \leq \text{2,6-[diexo]} \leq 40\ \%,$$

$$10\ \% \leq \text{2,6-[exo,endo]} \leq 40\ \%,$$

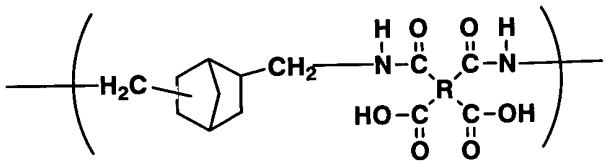
provided that

$$(\text{2,5-[diexo]}) + (\text{2,5-[exo,endo]}) + (\text{2,6-[diexo]}) + (\text{2,6-[exo,endo]}) = 100\ \%,$$

R represents a tetravalent group having from 4 to 27 carbon

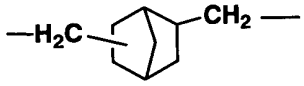
atoms and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

3. A polyamic acid having repeating units represented by the formula (1):

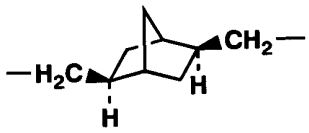


(1)

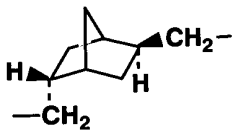
wherein the norbornane skeleton of



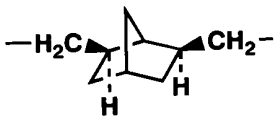
comprises four components of



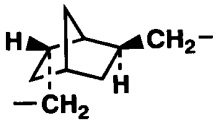
2,5-[diexo]



2,5-[exo,endo]



2,6-[diexo]



2,6-[exo,endo]

and their contents satisfy the following:

20 % ≤ 2,5-[diexo] ≤ 30 %,

20 % ≤ 2,5-[exo,endo] ≤ 30 %,

20 % ≤ 2,6-[diexo] ≤ 30 %,

20 % ≤ 2,6-[exo,endo] ≤ 30 %,

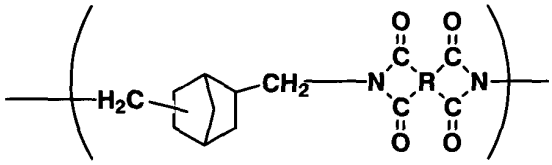
provided that

(2,5-[diexo]) + (2,5-[exo,endo]) + (2,6-[diexo]) +

(2,6-[exo,endo]) = 100 %,

R represents a tetravalent group having from 4 to 27 carbon atoms, and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

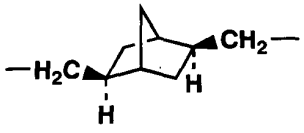
4. A polyimide having repeating units represented by the formula (2):



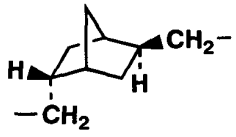
(2)

wherein the norbornane skeleton of

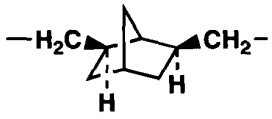
comprises four components of



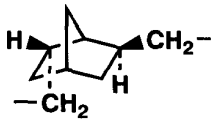
2,5-[diexo]



2,5-[exo,endo]



2,6-[diexo]



2,6-[exo,endo]

and their contents satisfy the following:

1 % ≤ 2,5-[diexo] ≤ 90 %,

1 % ≤ 2,5-[exo,endo] ≤ 90 %,

1 % ≤ 2,6-[diexo] ≤ 90 %,

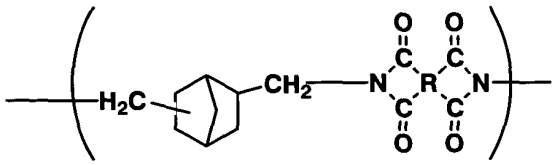
1 % ≤ 2,6-[exo,endo] ≤ 90 %,

provided that

(2,5-[diexo]) + (2,5-[exo,endo]) + (2,6-[diexo]) + (2,6-[exo,endo]) = 100 %,

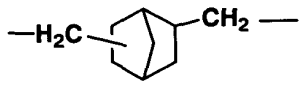
R represents a tetravalent group having from 4 to 27 carbon atoms and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

5. A polyimide having repeating units represented by the formula (2):

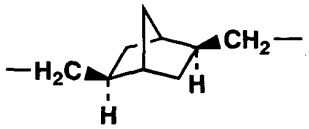


(2)

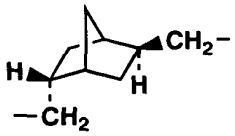
wherein the norbornane skeleton of



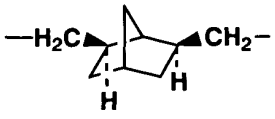
comprises four components of



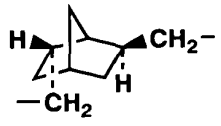
2,5-[diexo]



2,5-[exo,endo]



2,6-[diexo]



2,6-[exo,end]

and their contents satisfy the following:

10 % ≤ 2,5-[diexo] ≤ 40 %,

10 % ≤ 2,5-[exo,endo] ≤ 40 %,

10 % ≤ 2,6-[diexo] ≤ 40 %,

10 % ≤ 2,6-[exo,endo] ≤ 40 %,

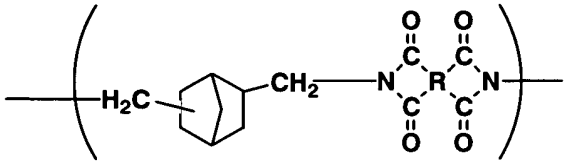
provided that

(2,5-[diexo]) + (2,5-[exo,endo]) + (2,6-[diexo]) +

(2,6-[exo,endo]) = 100 %,

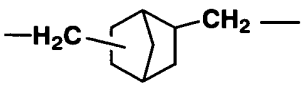
R represents a tetravalent group having from 4 to 27 carbon atoms and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

6. A polyimide having repeating units represented by the formula (2):

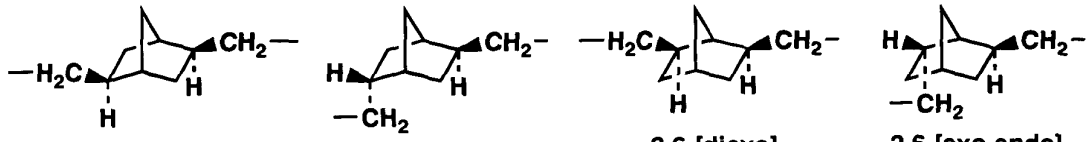


(2)

wherein the norbornane skeleton of



comprises four components of



and their contents satisfy the following:

$$20\ \% \leq 2,5\text{-[diexo]} \leq 30\ \%,$$

$$20\ \% \leq 2,5\text{-[exo,endo]} \leq 30\ \%,$$

$$20\ \% \leq 2,6\text{-[diexo]} \leq 30\ \%,$$

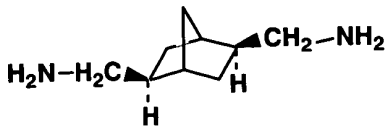
$$20\ \% \leq 2,6\text{-[exo,endo]} \leq 30\ \%,$$

provided that

$$(2,5\text{-[diexo]}) + (2,5\text{-[exo,endo]}) + (2,6\text{-[diexo]}) + (2,6\text{-[exo,endo]}) = 100\ \%,$$

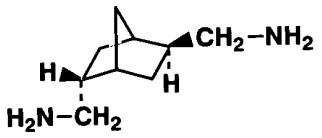
R represents a tetravalent group having from 4 to 27 carbon atoms, and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

7. A process for preparing a polyamic acid, which comprises reacting a mixture of diaminomethyl-bicyclo[2.2.1]heptanes, (2S,5S)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-1):



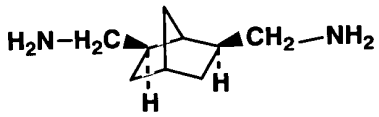
(3-1)

(2S,5R)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-2):



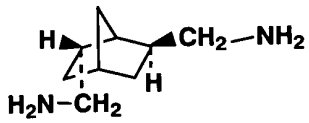
(3-2)

(2S,6R)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-3):



(3-3)

and (2S,6S)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-4):



(3-4)

wherein,

1 % ≤ (2S,5S)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 90 %,

1 % ≤ (2S,5R)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 90 %,

1 % ≤ (2S,6R)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 90 %,

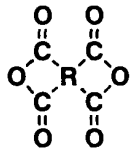
1 % ≤ (2S,6S)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 90 %,

provided that,

(2S,5S) isomer + (2S,5R) isomer + (2S,6R) isomer + (2S,6S)

isomer = 100 %,

with a tetracarboxylic dianhydride of a genera formula (4):

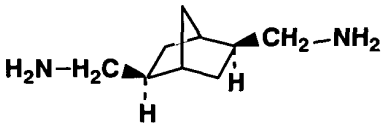


(4)

wherein R represents a tetravalent group having from 4 to 27 carbon atoms and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

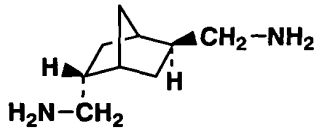
8. A process for preparing a polyamic acid, which comprises reacting a mixture of diaminomethyl-bicyclo[2.2.1]heptanes,

(2S,5S)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-1):



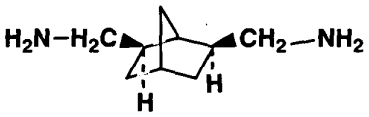
(3-1)

(2S,5R)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-2):



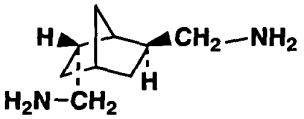
(3-2)

(2S,6R)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-3):



(3-3)

and (2S,6S)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-4):



(3-4)

wherein,

10 % ≤ (2S,5S)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 40 %,

10 % ≤ (2S,5R)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 40 %,

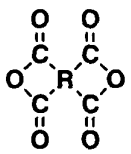
10 % ≤ (2S,6R)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 40 %,

10 % ≤ (2S,6S)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 40 %,

provided that,

(2S,5S) isomer + (2S,5R) isomer + (2S,6R) isomer + (2S,6S) isomer = 100 %,

with a tetracarboxylic dianhydride represented by the formula (4):

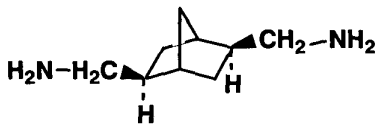


(4)

wherein R represents a tetravalent group having from 4 to

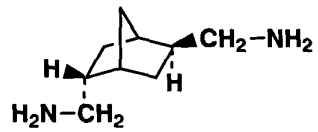
27 carbon atoms and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

9. A process for preparing a polyamic acid, which comprises reacting a mixture of diaminomethyl-bicyclo[2.2.1]heptanes, (2S,5S)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-1):



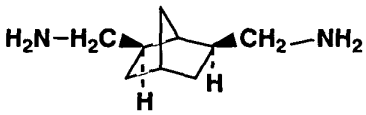
(3-1)

(2S,5R)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-2):



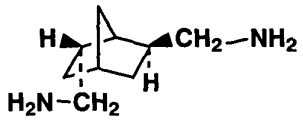
(3-2)

(2S,6R)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-3):



(3-3)

and (2S,6S)-diaminomethyl-bicyclo[2.2.1]heptane of formula (3-4):



(3-4)

wherein,

20 % ≤ (2S,5S)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 30 %,

20 % ≤ (2S,5R)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 30 %,

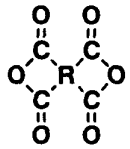
20 % ≤ (2S,6R)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 30 %,

20 % ≤ (2S,6S)-diaminomethyl-bicyclo[2.2.1]heptane ≤ 30 %,

provided that,

(2S,5S) isomer + (2S,5R) isomer + (2S,6R) isomer + (2S,6S) isomer = 100 %,

with a tetracarboxylic dianhydride represented by the formula (4):



(4)

wherein R represents a tetravalent group having from 4 to 27 carbon atoms and selected from the group consisting of an aliphatic group, a monocyclic aliphatic group, a condensed polycyclic aliphatic group, a monocyclic aromatic group, a condensed polycyclic aromatic group, and a non-condensed polycyclic aliphatic or aromatic group

which is composed of cycloaliphatic or aromatic groups mutually bonded to each other either directly or via a crosslinking member.

10. A process for preparing a polyimide, which comprises thermally or chemically imidizing the polyamic acid obtained in claim 7.

11. A process for preparing a polyimide, which comprises thermally or chemically imidizing the polyamic acid obtained in claim 8.

12. A process for preparing a polyimide, which comprises thermally or chemically imidizing the polyamic acid obtained in claim 9.

Sub A1

13. The polyamic acid of claim 1, 2 or 3, of which the inherent viscosity measured in a solvent of N-methyl-2-pyrrolidone having the acid concentration of 0.5 g/dl at 35°C falls between 0.1 and 3.0 dl/g.

14. The polyimide of claim 4, 5 or 6, of which the inherent viscosity measured in a mixed solvent of p-chlorophenyl/phenol = 9/1 (by weight) having the polyimide concentration of 0.5 g/dl at 35°C falls between 0.1 and 3.0 dl/g.

15. A polyamic acid varnish containing the polyamic acid of claim 1.

16. A polyamic acid varnish containing the polyamic acid of claim 2.

17. A polyamic acid varnish containing the polyamic acid of claim 3.

18. A polyimide film containing the polyimide of claim 4.

19. An amorphous polyimide film containing the polyimide of claim 5.

20. An amorphous polyimide film of improved smoothness, containing the polyimide of claim 6.

Add A2